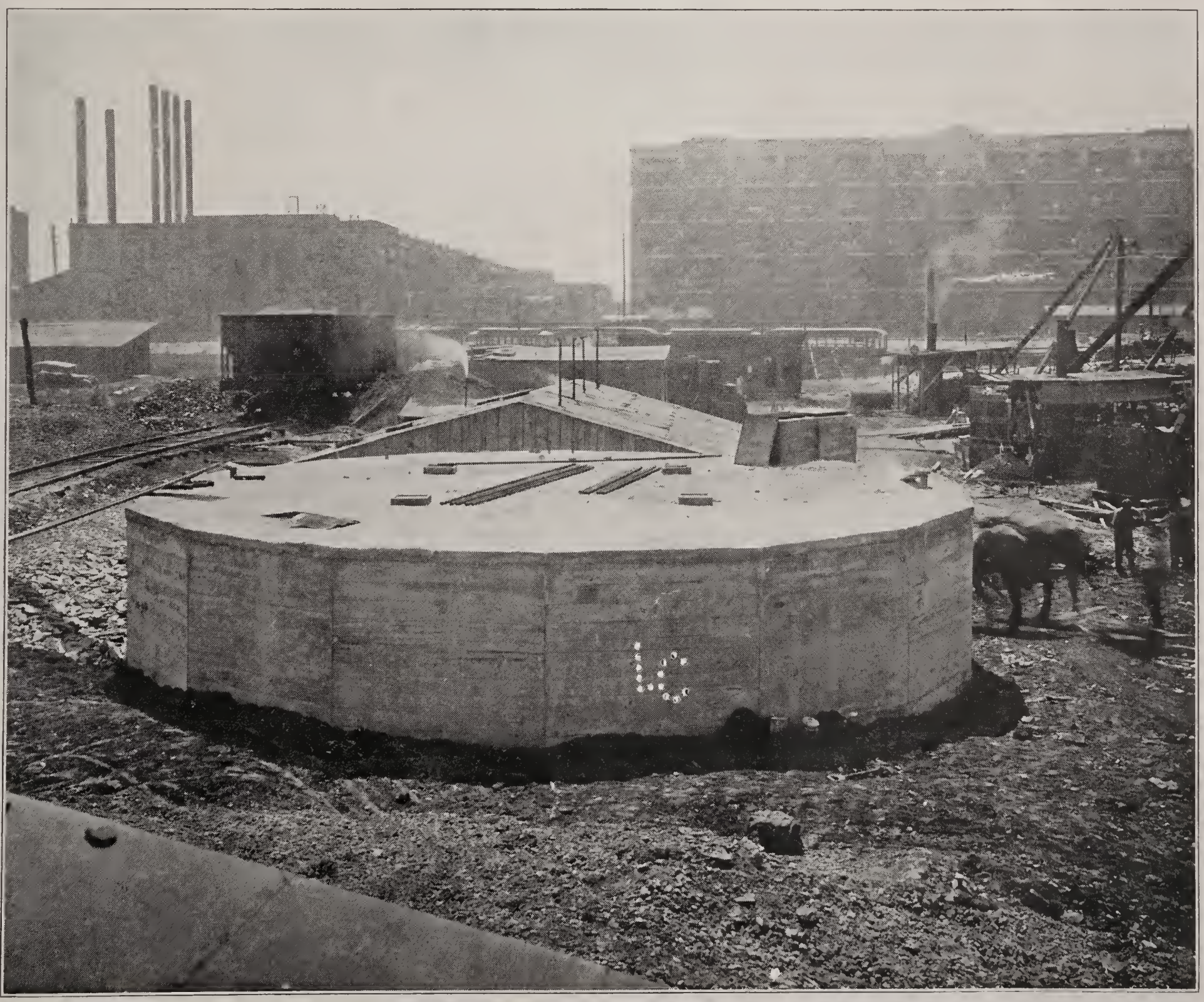
Oil Storage Tanks of Concrete

The Atlas Portland Cement Company

New York Philadelphia Boston Savannah
Chicago St. Louis Minneapolis Des Moines Dayton



"The standard by which all other makes are measured."

Introduction

THE engineering profession, after extensively adopting reinforced concrete for general purposes, is rapidly developing its use for special structures. As these developments take place many other materials of construction are being replaced.

One of the latest and most interesting problems that the engineer has been called upon to solve is the economical and efficient storage of various oils. Reinforced concrete has been used for oil tank construction for a number of years. However, the most rapid development has taken place during the past two years.

Concrete was first used in the oil fields for lining oil storage reservoirs. Concrete tanks have now been constructed in varied units and have proven successful for either large or small capacities. This makes the subject one of interest to the large oil producers, refiners and manufacturing industries where oil is used either in the process or as fuel. Exact design and careful construction are both of great importance in this type of tank. A concrete oil tank, properly designed and carefully inspected during construction, will give entire satisfaction to the owners.

The Atlas Portland Cement Company has taken a most active part in the various stages of concrete oil tank development. This brief treatise on the subject has been prepared for distribution among those interested. Realizing the great importance of continuing this branch of the concrete industry on a sound and lasting basis, it was thought timely to illustrate the book with a few plans and pictures representative of the thousands of tanks which have been constructed throughout the country.

View of 182,000 Gallon Tank for Fuel Oil

OWNER: *American Brakeshoe and Foundry Company, Erie, Pa.*
DESIGNER AND BUILDER: *Con-Oil Tank Company, 1215 Fulton Building, Pittsburgh, Pa.*

Oil Storage Problems Solved by Using Reinforced Concrete Tanks

THE above picture gives a good idea of the unique design of this tank. The ground plan of a tank is generally in the form of a circle, rectangle or square. It can be seen that this is a polygon. The picture was taken immediately after the removal of forms, and shows the fill started on one side. The tank was finally covered with 3 feet of earth. The manhole is seen at the right side of the top extending 3 feet above the roof to allow for the earth fill.

Figure I, at the top of the right-hand page, shows the details of the design. Great care was taken in this design to prevent either temperature cracks or cracks due to stresses developing in the completed structure. The spread footings for the 10-inch walls and columns, the 2 x 2 columns, the 10-inch floor, the 20-inch floor beams and 8-inch roof, all sufficiently reinforced, make this an admirable design for this specific location and use.

The picture on the lower right-hand page shows the interior after the removal of forms. The manhole opening and iron ladder can be seen at the right.

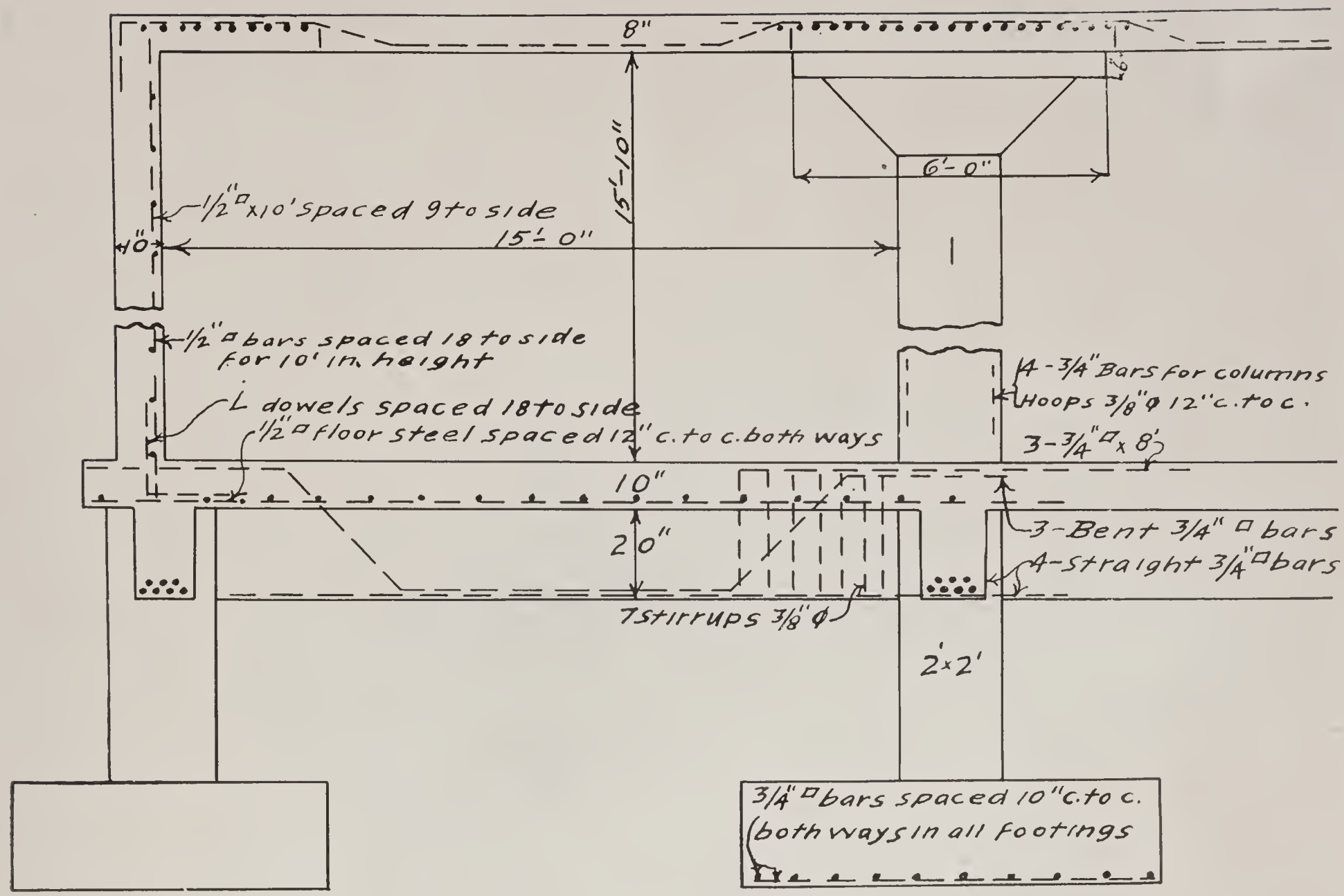
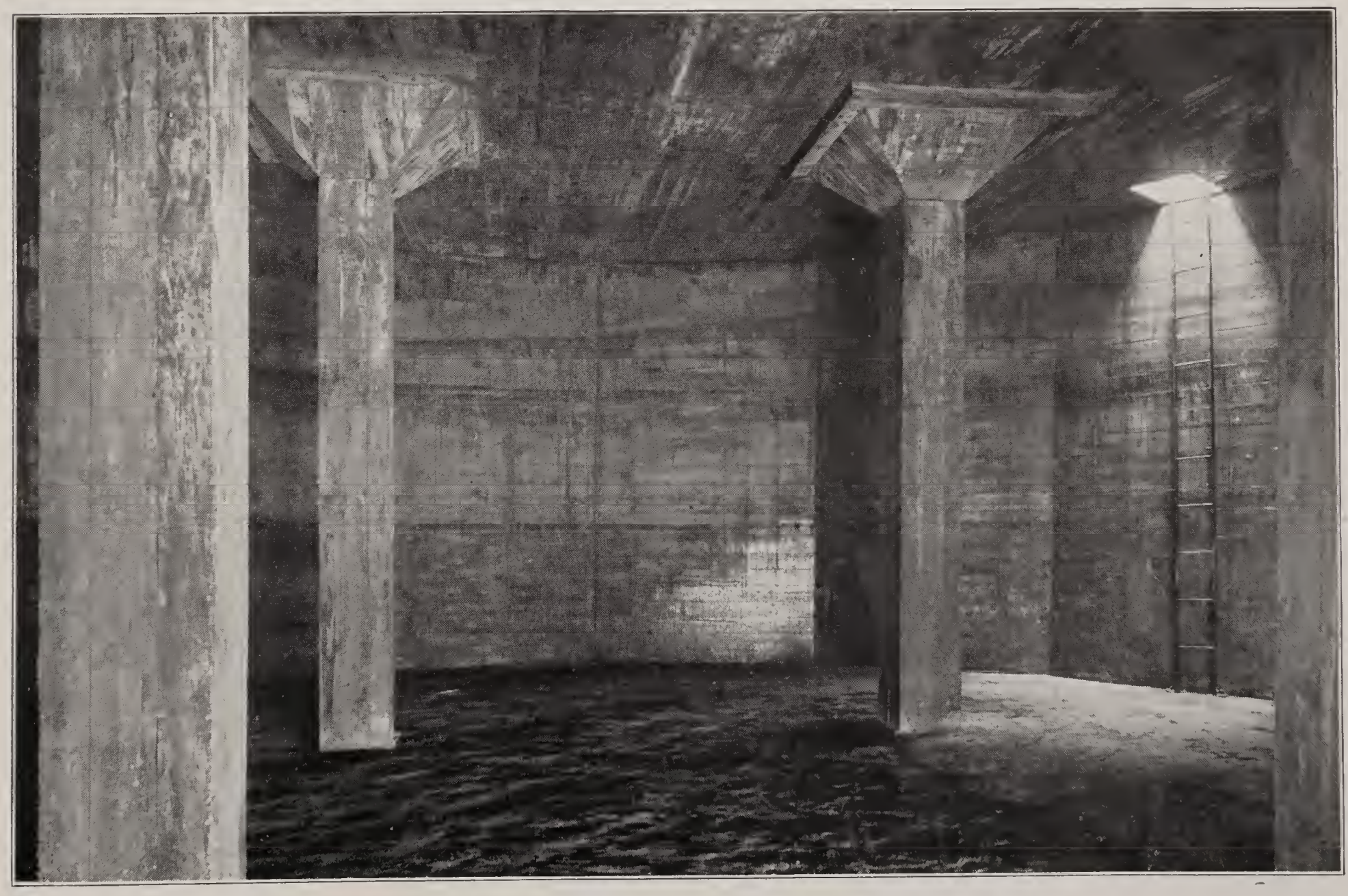


Figure I—Section Through Tank



Interior View of 182,000 Gallon Underground Tank

Ground View of Two 100,000 Gallon Tanks for Fuel Oil

OWNER: *American Can Company, Bridgeport, Conn.*
DESIGNER: *R. R. Allison, 268 Maplewood Avenue, Bridgeport, Conn.*
BUILDER: *Schwartz Bros., Bridgeport, Conn.*

AT the Liberty Ordnance Plant of the American Can Company, Bridgeport, Conn., the management has planned for 400,000 gallons of oil storage. The general plan for this storage, called for four 100,000 gallon tanks, each tank divided into four compartments, thus making separate units of 25,000 gallon capacity. At the present time two of the tanks are completed, giving a total capacity of 200,000 gallons. The plans are to build the other two tanks as the storage facilities are required.

It is a very difficult matter to obtain a photograph which shows to good advantage a completed underground tank. The above picture shows the top of the two completed tanks. The small building is the pump house. Six 3-inch vent pipes can be seen. The oil gauge is seen to the left of the pump house. By comparing the picture with Figure A it will be noted that the tank in the foreground of the picture is Tank No. 1, as plotted in Figure A. Tank No. 2 is shown in the right background of the picture, being at right angles to Tank No. 1. Figure II shows a longitudinal section taken through two compartments. A roof beam 14 inches wide, 21 inches deep, extends the length of the tank, a cross section of which is shown in Figure III. This figure also shows the tunnel passage which is used for the inlet and suction pipes.

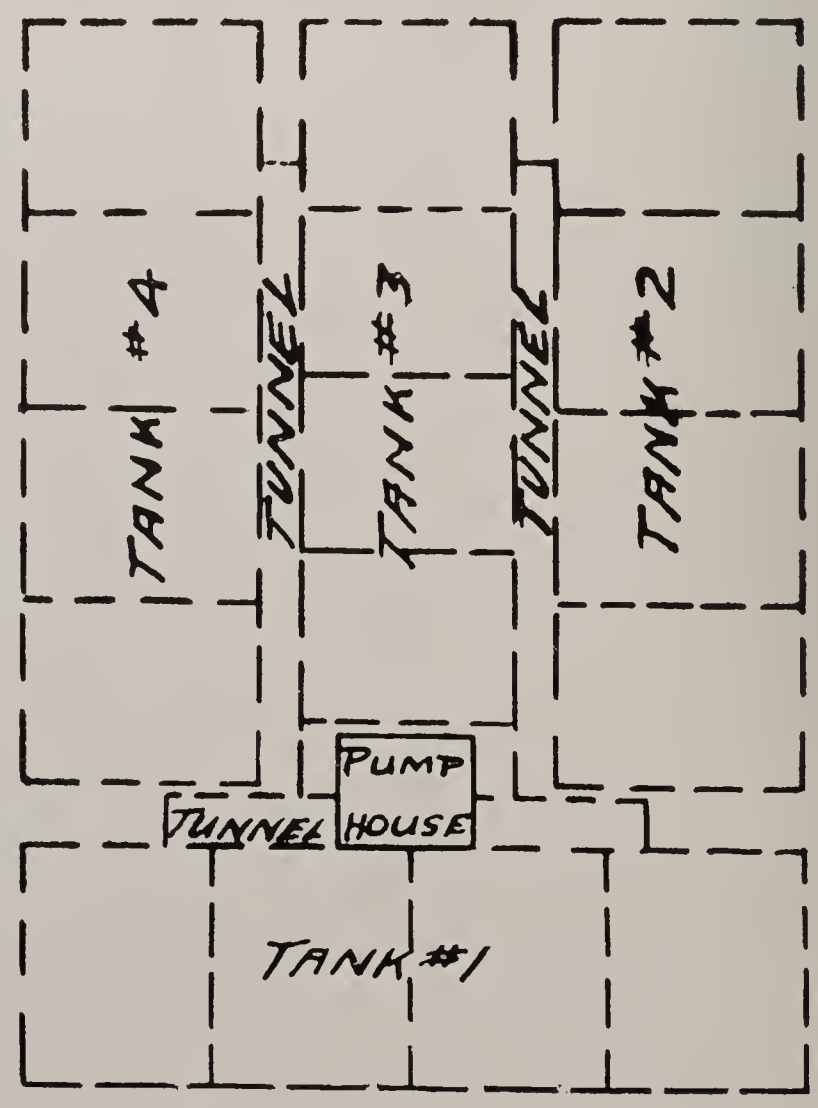


Fig A—Plan of 4—100,000 Gallon Tanks

It will be noted that a manhole is placed in each compartment. The interior surfaces of these tanks have been oilproofed with a coating of Portland cement mortar mixed with "Impervite." The tanks have been tested for some time in actual service and have proven entirely successful.

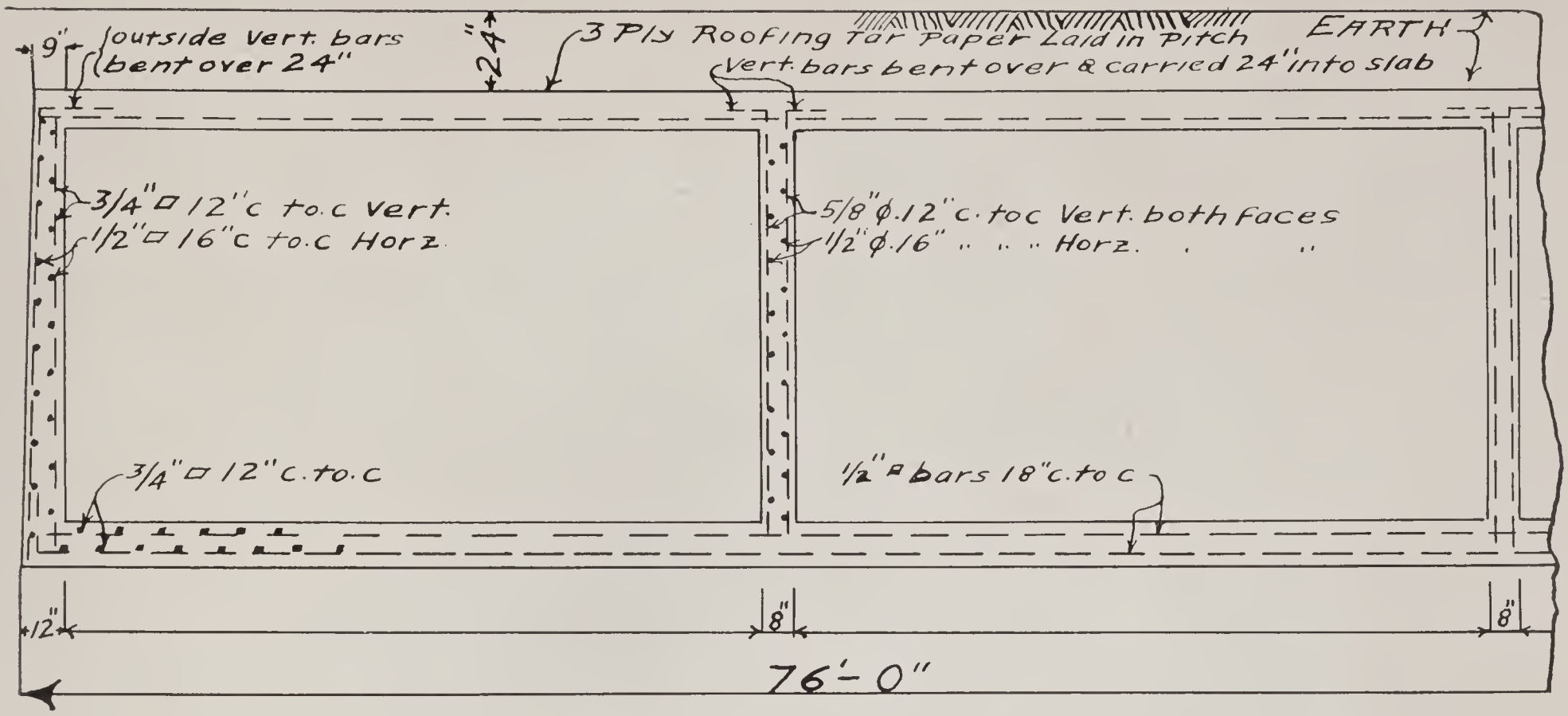


Figure II—Longitudinal Section Through Two Compartments

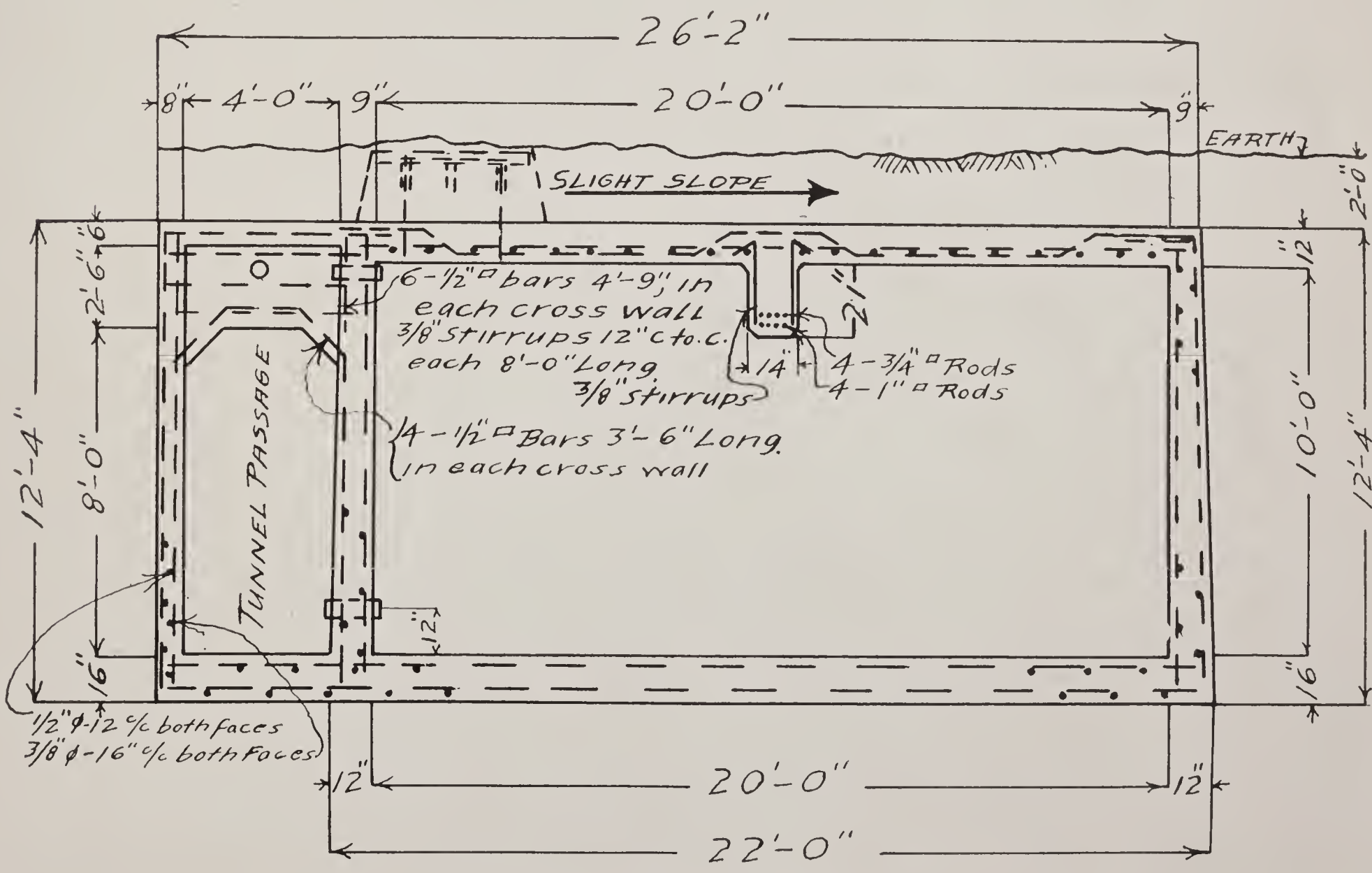


Figure III—Cross Section

Concreting Method for Floor Slab of 200,000 Gallon Tank

OWNER: *The Pullman Company, Pullman, Ill.*
DESIGNER AND BUILDER: *L. J. Mensch, 138 North La Salle Street, Chicago, Ill.*

THE above picture shows the reinforcing in place for the floor slab of one tank of 200,000 gallon capacity. It can be seen that the reinforcing rods have been placed carefully and a good idea of efficient concreting methods can be obtained from this view. A capacity of 400,000 gallons, two tanks, was required at this plant. There are a number of advantages obtained in dividing a tank into compartments. One of the greatest advantages is the effect on the roof design. A shorter roof span diminishes the required thickness and also eliminates the use of columns. Aside from the structural advantages there is one which sometimes is a necessity in the use of the tank and that is the storage of different kinds of oil. This tank can be used for oils of four different gravities, as the four compartments are entirely separated.

Figure IV, on the right-hand page, shows the design details of floor and sidewalls. The 8-inch wall is the outside wall of the tank and the 12-inch wall is a dividing wall. Figure V shows a section through two of the tanks or two compartments, showing two 12-inch dividing walls. The filling, suction and other pipes are indicated by circles in the center of each tank near the top. It will be noted that the floors are sloped to the center and that a 3-foot sump has been provided. It is also interesting to note that the top slope of the floor is also used on the sub-grade. This feature of the design cuts down the required quantity of concrete to a great extent. The inside surfaces of these tanks were oilproofed with a coating of Ironite. Concrete construction was chosen for this work because of the great saving in cost and the facilities for rapid erection. The tanks have proven invaluable to the owners and have given complete satisfaction.

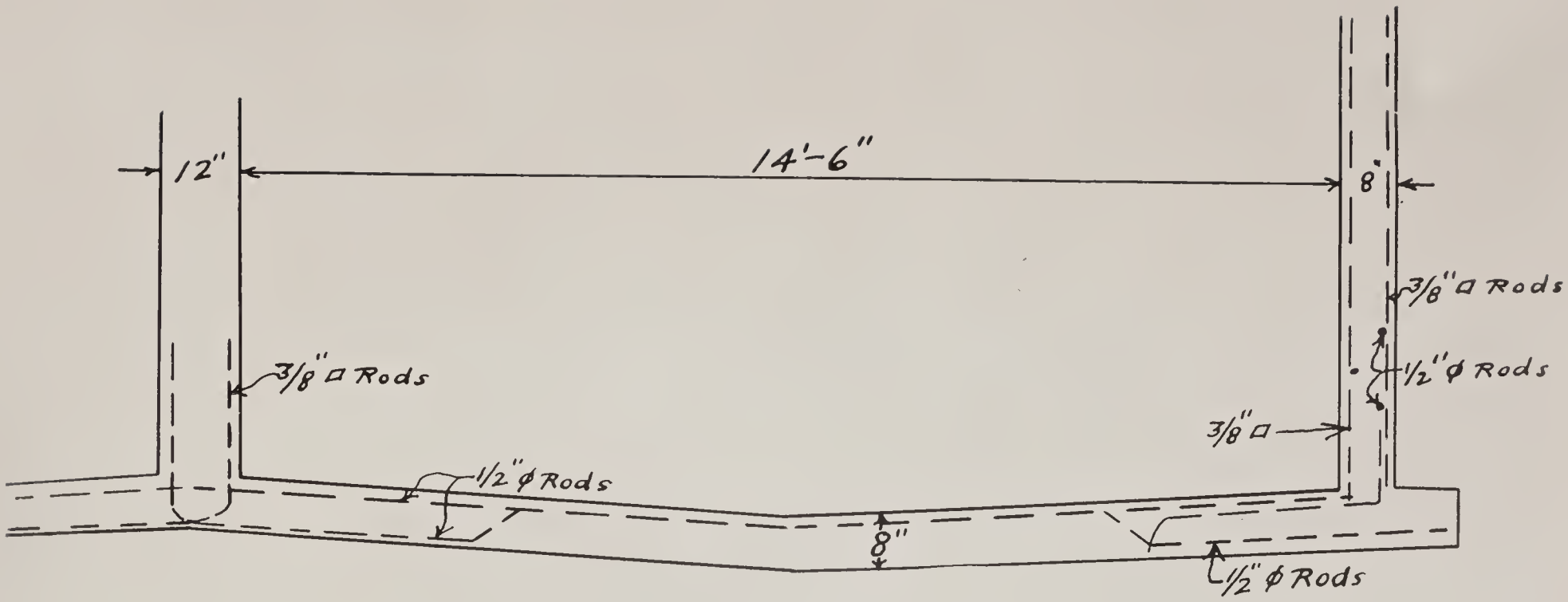


Figure IV—Section Through Two Compartments

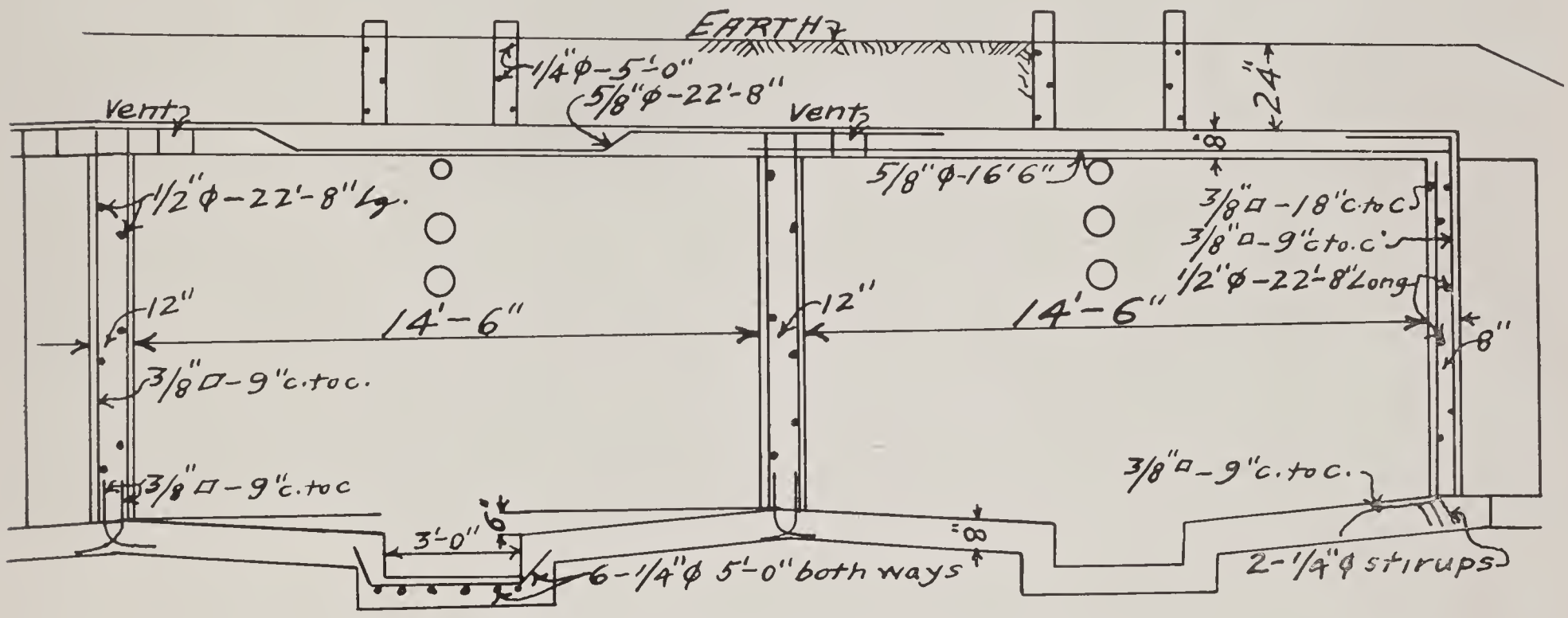


Figure V—Section Through Floor, Sidewalls and Roof

View Showing Small Construction Plant Required for 200,000 Gallon Tank

Interior View of 30,000 Gallon Tank

OWNER: *Erie City Iron Works, Erie, Pa.*
DESIGNER AND BUILDER: *Con-Oil Tank Company, 1215 Fulton Building, Pittsburgh, Pa.*

TWO 30,000 gallon fuel oil tanks were recently built for the Erie City Iron Works, at Erie, Pa. The picture above is an interior view of one of these tanks. This tank was designed to carry a standard gauge railroad track supported on the roof slab. This is an interesting feature of concrete oil tank construction, showing that tanks can be placed either in sub-basements of buildings, under plant roadways or in other out-of-the-way places, thereby making available more ground area for other manufacturing purposes or storage of materials.

Figure XI shows a cross section and Figure XII a longitudinal section. It is interesting to note the heavy floor slab, heavy columns and roof beams, all made necessary by the tremendous loading of the locomotives and trains passing over. This is a comparatively small tank. However, the same care was necessary in the design and construction as is given the larger tanks. Test pits were dug to determine the bearing value of the soil.

These tanks have given complete satisfaction to the owners. The design of this tank emphasizes the fact that the roof of a concrete tank can be designed to carry any given load. This means that future developments, such as new buildings, changes in rail-

road siding alignment and all other improvements that take place almost daily in a growing manufacturing plant can be planned and carried out without considering the location of the concrete oil storage tanks.

It is a well-known fact that in the past, ground area devoted to oil storage could be used for no other purpose. Plant engineers will not fail to agree that this is a great advantage of concrete construction. The officials of the Erie City Iron Works have put this theory into practice.

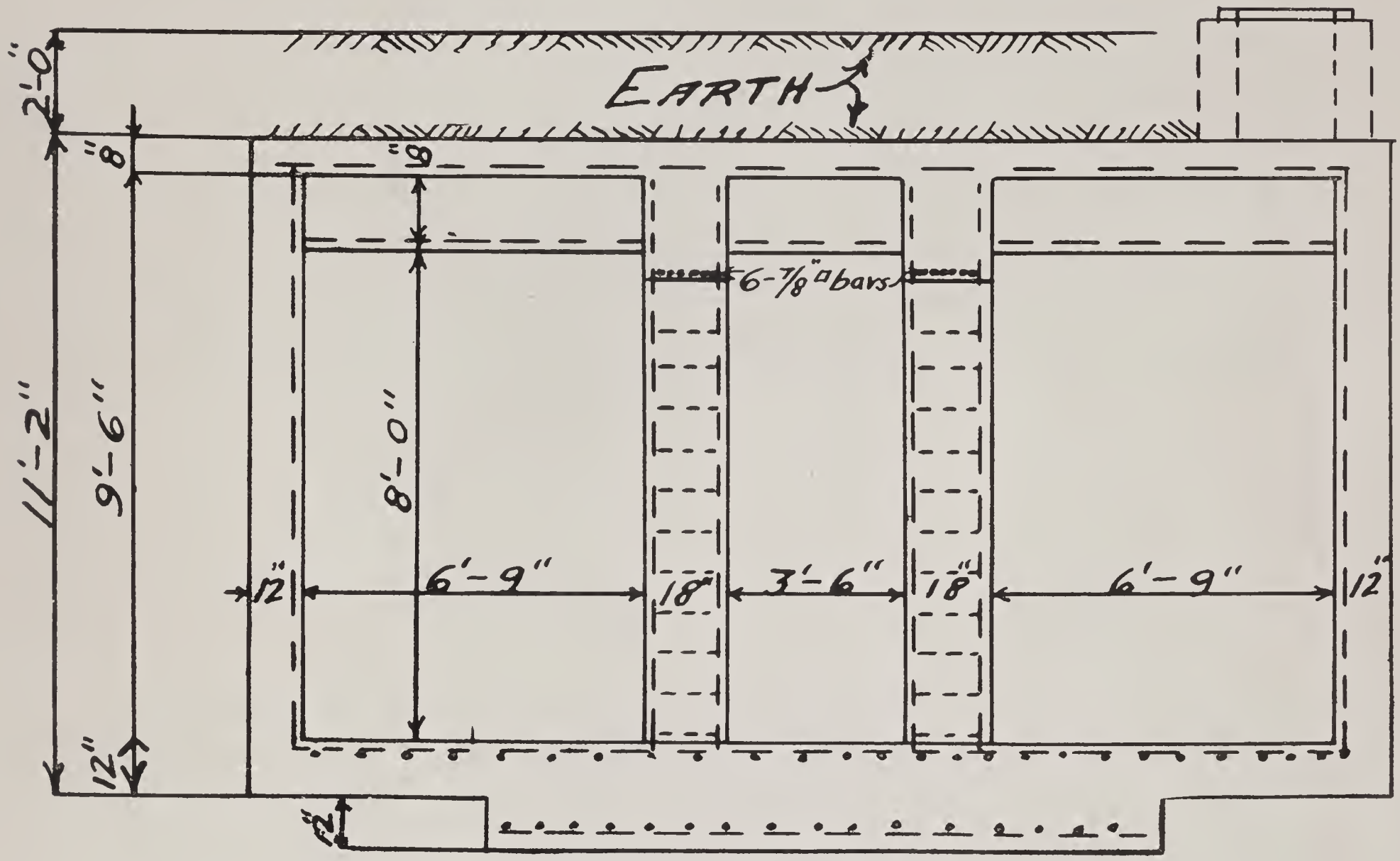


Figure XI—Cross Section

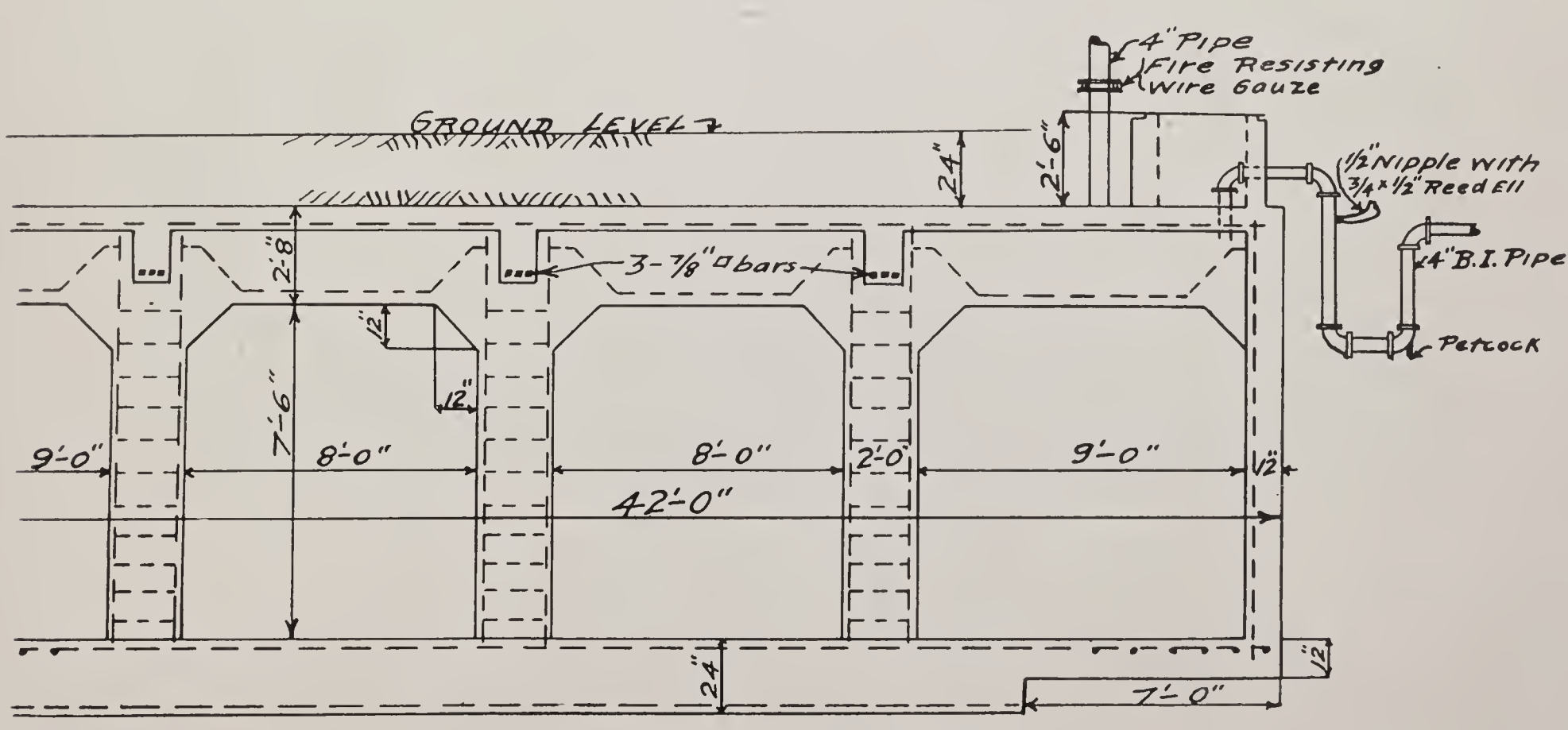


Figure XII—Longitudinal Section

20,000 Gallon Fuel Oil Tank Before Removal of Forms

OWNER: *American Brakeshoe and Foundry Company, 4616 West 26th Street. Chicago.*
DESIGNER: *L. J. Mensch, Chicago.* BUILDER: *L. J. Mensch, Chicago.*
SIZE: *12 x 28 x 8 feet 6 inches inside. Tank oilproofed with Ironite.*

DESIGNED TO CARRY 1,000 LBS. PER SQ. FT. FOR STORING STEEL BARS. OWNERS ARE ENTIRELY SATISFIED.

View Showing Floor Finishing of 20,000 Gallon Tank

OWNER: *Vaughn & Bushnell, 2114 West Carroll Avenue, Chicago.*
DESIGNER: *L. J. Mensch, Chicago.* BUILDER: *L. J. Mensch, Chicago.*
DIMENSIONS: *9 x 54 x 5 feet. Tanks oilproofed with Ironite. Tanks will be covered with two feet of earth. Walls 8 inches thick—roof 7½ inches thick. Designed to carry 10-ton truck. Owners are completely satisfied.*

Preliminary Report on Fuel Oil Storage

Inspection Department, Association of Factory Mutual Fire Insurance Companies
31 Milk Street, Boston, Mass.

GENERAL REQUIREMENTS FOR CONCRETE TANKS

The general requirements for a successful concrete tank for the storage of fuel oil are given below, although these should not be considered as detailed specifications:

1. *Foundations.* The tank should rest upon secure footings to guard against settlement.

2. *Reinforcement.* Sufficient steel reinforcement should be used to resist the oil pressure, and the horizontal and vertical reinforcement should be properly proportioned and located to reduce the shrinkage cracks so that they will be too minute to permit leakage. To accomplish this, the fibre stress in the steel should not exceed 10,000 lbs. per square inch. Some designers use as low as 6,000 to 8,000 lbs.

3. *Concrete.* The concrete for the floor and walls should be at least 8 inches thick, mixed in the proportions of 1:2:3, or better, 1:1½:3, and having the coarse aggregate of clean, dense, crushed rock or gravel, ranging in size from 1 inch down. The concrete should be thoroughly mixed, carefully placed and worked around the reinforcement. The forms should not be held together by wires as is frequently done in building construction, because leakage is apt to take place along the wire.

The concrete should be poured in as continuous an operation as possible and preferably without any interruption, so as to form a monolithic construction. Where this cannot be done, the bottom should be poured without joints, and the walls as a second continuous operation. One method of making a tight joint between the bottom and the walls is by means of a strip of galvanized iron 6 inches wide, with joints riveted and soldered so as to form a continuous band. This strip should be vertically imbedded 3 inches in the floor slab and projecting 3 inches into the walls about on the center line. The floor slab under the walls should be thoroughly cleaned, and before pouring the walls, a mixture of 1:1 mortar should be placed in the bottom of the forms and around the galvanized strip to make a tight joint.

4. *Finish.* As soon as the floor has been poured it should be "floated" and troweled smooth. The wall forms should be removed as soon as the concrete is hard enough to be self-sustaining, and all projections and irregularities should be removed from the surface, and all cavities filled with a 1:1 mortar thoroughly rubbed in and troweled smooth, but no plastering should be applied because it is liable to peel off under the action of temperature changes. The concrete should be allowed to harden and age at least a month, and more if possible, before filling the tank with oil, as this will greatly increase its oil-tightness. To assist in this process and enable the concrete to harden before becoming oil-soaked, it is advantageous to apply several coats of a 1 to 4 solution of 40 degrees Be. sodium silicate, followed by a finish coat of a 1 to 2 solution. This forms a glazed surface on the concrete, but does not last more than a year, and when its purpose of allowing the concrete to harden has been fulfilled its presence is no longer necessary.

5. *Cost of Concrete Tanks.* Reinforced concrete tanks are being today constructed below ground at prices ranging from 6 to 10 cents per gallon capacity, depending upon the size of the tank and difficulties of excavation. Circular tanks are somewhat more economical than rectangular ones. Steel tanks above ground in the Pittsburgh District are being furnished and erected upon foundations for about 4 cents per gallon. When buried they have to be braced inside to resist external pressure and then the price rises to about 9 cents per gallon. In other parts of the country freight charges will have to be added, which will increase the above costs accordingly.

UNLOADING STATION

One of the most common sources of trouble in handling fuel oil is due to accident when unloading from the cars. There are a number of cases on record where the valve in the tank car connection has leaked so badly that when the cap beyond

[*Page Eleven*]

the outlet was removed from the outlet the whole or a large part of contents of the car escaped upon the ground. For this reason, it is extremely important that the grade at the unloading station should slope away from buildings, lumber piles, etc. The best arrangement is to provide a concrete basin large enough to catch the contents of an entire car should accident occur. This also serves to protect the ground in the vicinity from becoming oil-soaked. The connection for unloading the oil from the tank cars should contain a strainer and should be made either with a pipe having swinging joints or with a flexible metallic hose, avoiding the use of rubber hose.

GENERAL ARRANGEMENT OF PIPING

All connections to buried tanks and the filling connection for tanks above ground should be made at the top. A vent with a spark arrester should also be provided at the top of the tanks. For tanks above ground, the outlets are generally connected at the bottom with a valve bolted directly to a nozzle attached to the tank and with another valve located outside the earth levee.* The discharge pipe in this case should pass over the top of the levee instead of being buried in it. The suction pipes from underground tanks should be provided with a foot valve and strainer and arranged either with a swing joint or provisions for lifting vertically for examination and repairs. All piping and fittings should be extra heavy and tested at 150 lbs. water pressure for two hours. All valves should be outside screw-and-yoke type, so that their positions can be seen at a glance.

FILLING CONNECTIONS FOR SERVICE TANKS

When underground service tanks are filled from the large storage tanks, either by gravity or by means of pumps, the filling connection should consist of an open funnel and valve so that no pressure could be placed upon the service tanks and through them upon the piping in the buildings.

PUMPS

For large installations two pumps are advised, with the piping so arranged that the pumps can be used either independently or together for pumping into the storage tanks or out of them. This is desirable in case it is necessary to fill the service tanks at the same time a car is being unloaded. The pumps should be located in a pump house of non-combustible construction. If electrically driven pumps are used, the motors should be cut off from the pump room by a non-combustible partition and the pumps operated by shafts passing through the wall. The switches and fuses should all be located in the motor room.

As 16 feet is about the maximum practical lift for an oil pump, it is sometimes necessary to use a "deep well" type of pump for excessive lifts, with the impeller at the lower end of vertical shaft.

* Tanks Above Ground. In the case of oil storage tanks which are already above ground or which have to be located there because of a ledge or other reasons, the following safeguards should be provided:

When the tanks are at a safe distance from buildings, it is usually sufficient to surround them by an earth levee, large enough to contain one and one-half times the capacity of the tank with an allowance for accumulation of snow and water. The tanks and levees should be a sufficient distance apart so that a fire in any one of them would not involve the others.

When the tanks are above ground and near important buildings, they should be surounded by a concrete wall and the space between the wall and the tanks filled with clean, sound earth deep enough to cover the top of the tank about 18 inches or 2 feet.

C. W. Mowry,
Engineer and Special Inspector.

100,000 Gallon Oil Tank

OWNER: *Osgood-Bradley Car Company, Worcester, Mass.*
DESIGNER AND BUILDER: *Con-Oil Tank Company,*
1215 Fulton Building, Pittsburgh, Pa.

Tank designed to support railroad track.
Picture shows Roof Reinforcing Steel in place.
Concrete Plant mounted on flat car works efficiently.

20,000 Gallon Tank for Light Fuel Oil

DESIGNED, BUILT AND OWNED *by the D. & W. Fuse Company, Providence, R. I.*

THIS tank was built for the storage of 20,000 gallons of very light fuel oil, having about the same gravity as kerosene. A picture of the completed tank is shown above. At the far end is seen the pipe chamber. This chamber is 6 x 4 feet in plan, and extends from the surface of the ground to the top of the tank floor—a distance of 8 feet 11 inches. Both the intake and suction pipes are run through the wall between the pipe chamber and tank. The pipe chamber is also used for inspecting the tank. Figure VII shows a longitudinal section through one end of the tank and the pipe chamber, and Figure VIII shows a cross section of the tank.

The fact that a very light oil was to be stored, made it imperative to devote some thought to the proper oilproofing methods to be used. A number of different oil-proofing materials were experimented with, and tested, after being applied to small slabs of concrete and subjected to the action of gasoline. The owners decided to use a product for this work which they have themselves developed. Their process makes concrete absolutely impervious to the light fuel oil which was to be stored in this tank.

It will be well to bear in mind, when looking over this design, that the underlying soil is of a dry, sandy nature and afforded a good, stable foundation, and, therefore, the usual spread footings and floor beams were eliminated.

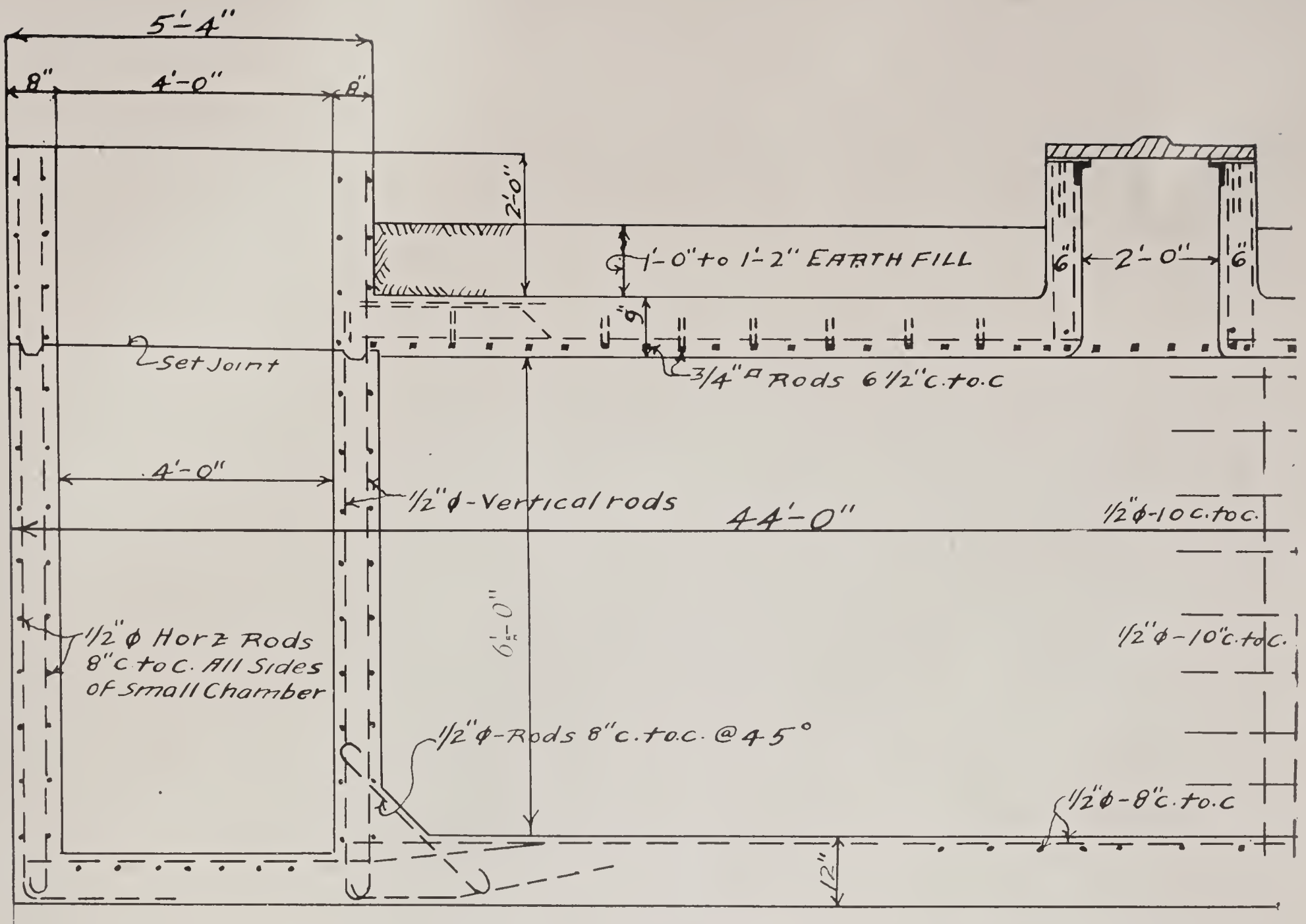


Figure VII—Longitudinal Section

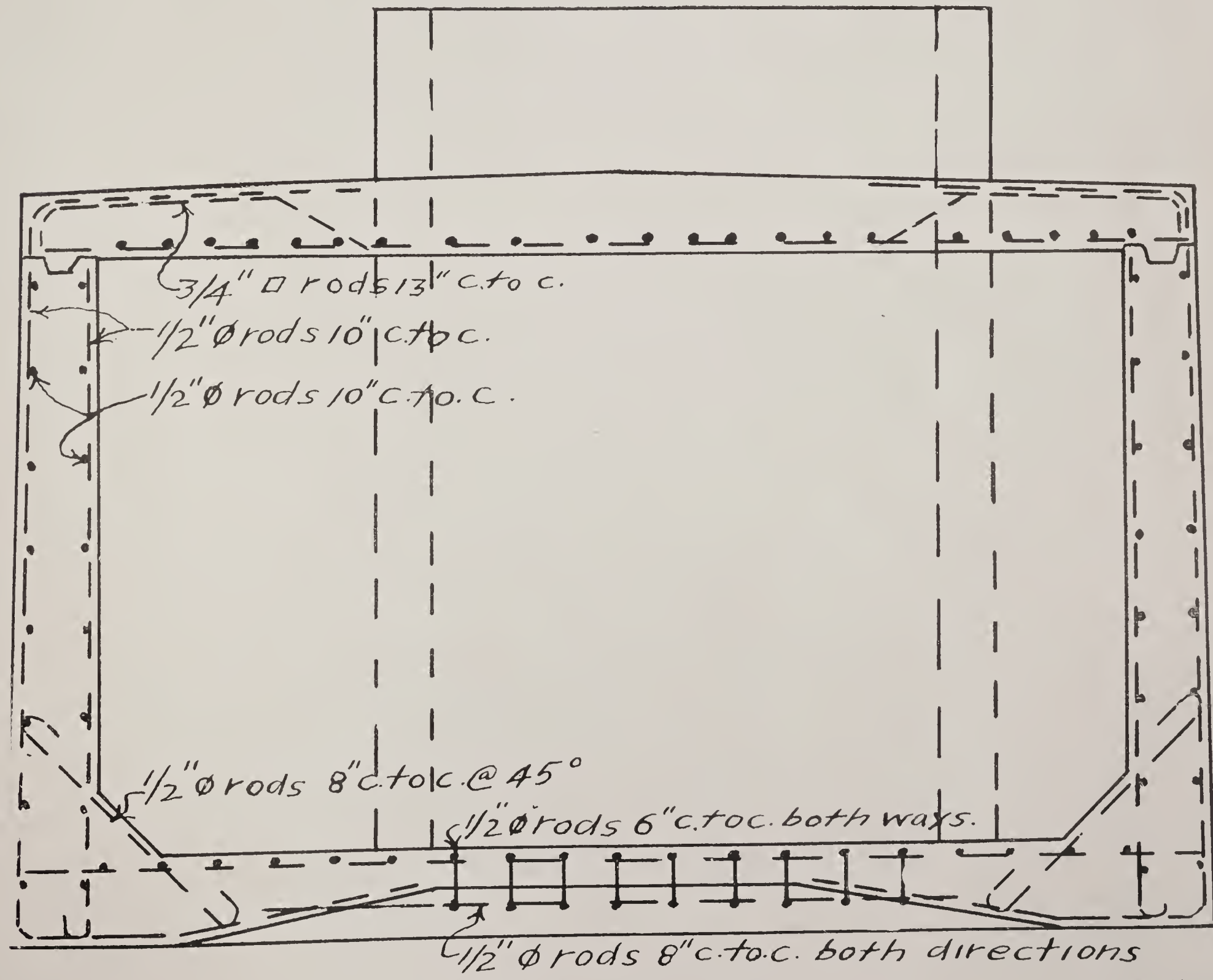


Figure VIII—Cross Section

Interior View of 150,000 Gallon Tank

OWNER: *Steel Car Forge Company, Ellwood City, Pa.*
DESIGNER AND BUILDER: *Con-Oil Tank Company, 1035 Dime Building, Detroit, Mich.*

THE above picture is an interior view of a 150,000 gallon fuel oil tank, which shows the floor, columns and roof. Figure IX is a half plan, showing the outside walls, the 3 foot 6 inch wall footings, the floor slab, the 7 foot square column footings and the columns spaced 11 feet 6 inches, center to center.

Figure X is a part section through the tank, showing the wall and column 12 inch footings, the 12 inch floor, the 18 inch columns, which have a 4 foot 6 inch square

cap, the 10 inch side walls, the 8 inch roof slab, the 2 foot 6 inch square manhole 2 feet above the roof slab, and the location of the pipe line, as well as details of the same.

The greatest diameter is 46 feet and the inside height 13 feet.

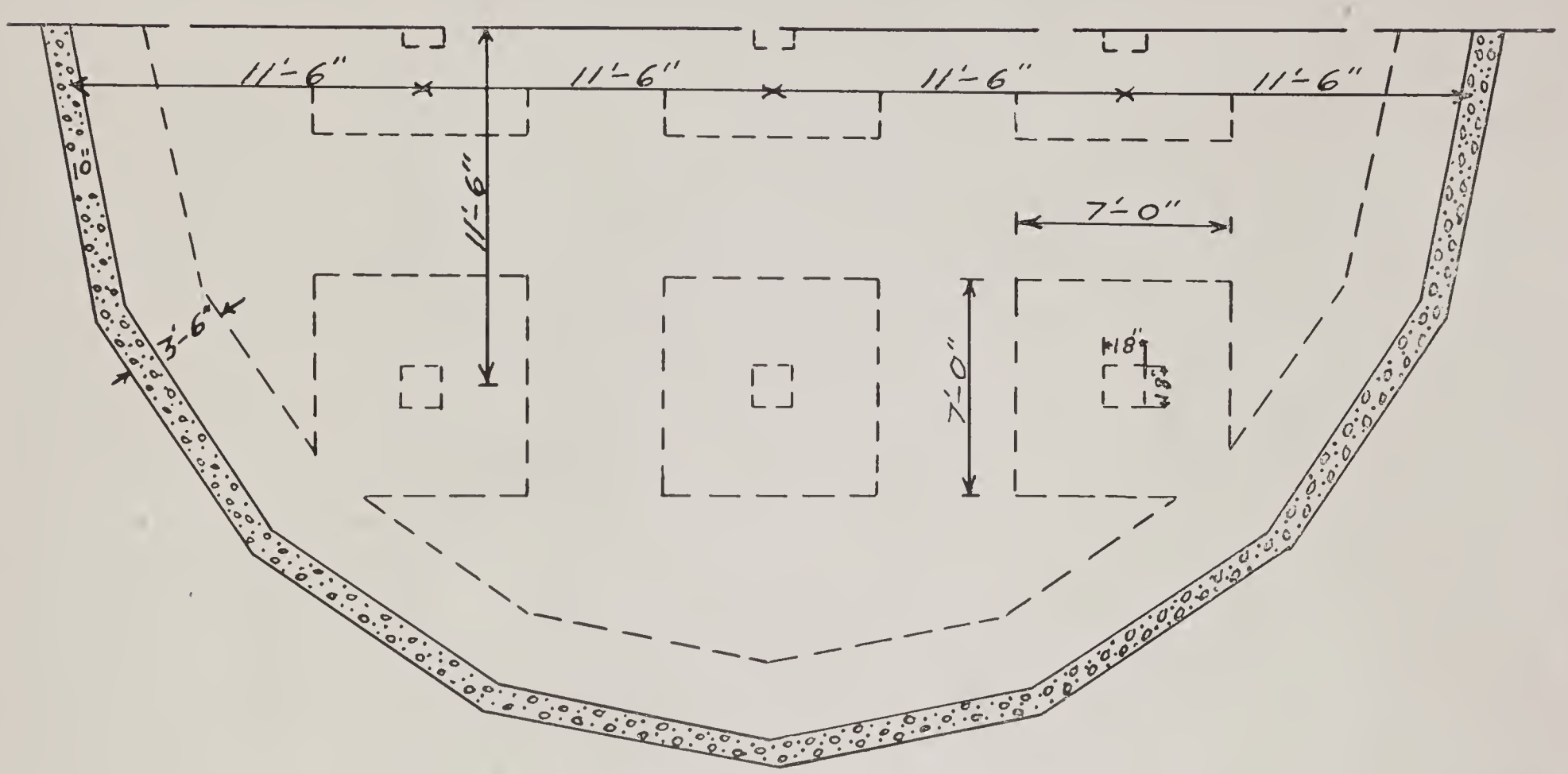


Figure IX—Half Floor Plan

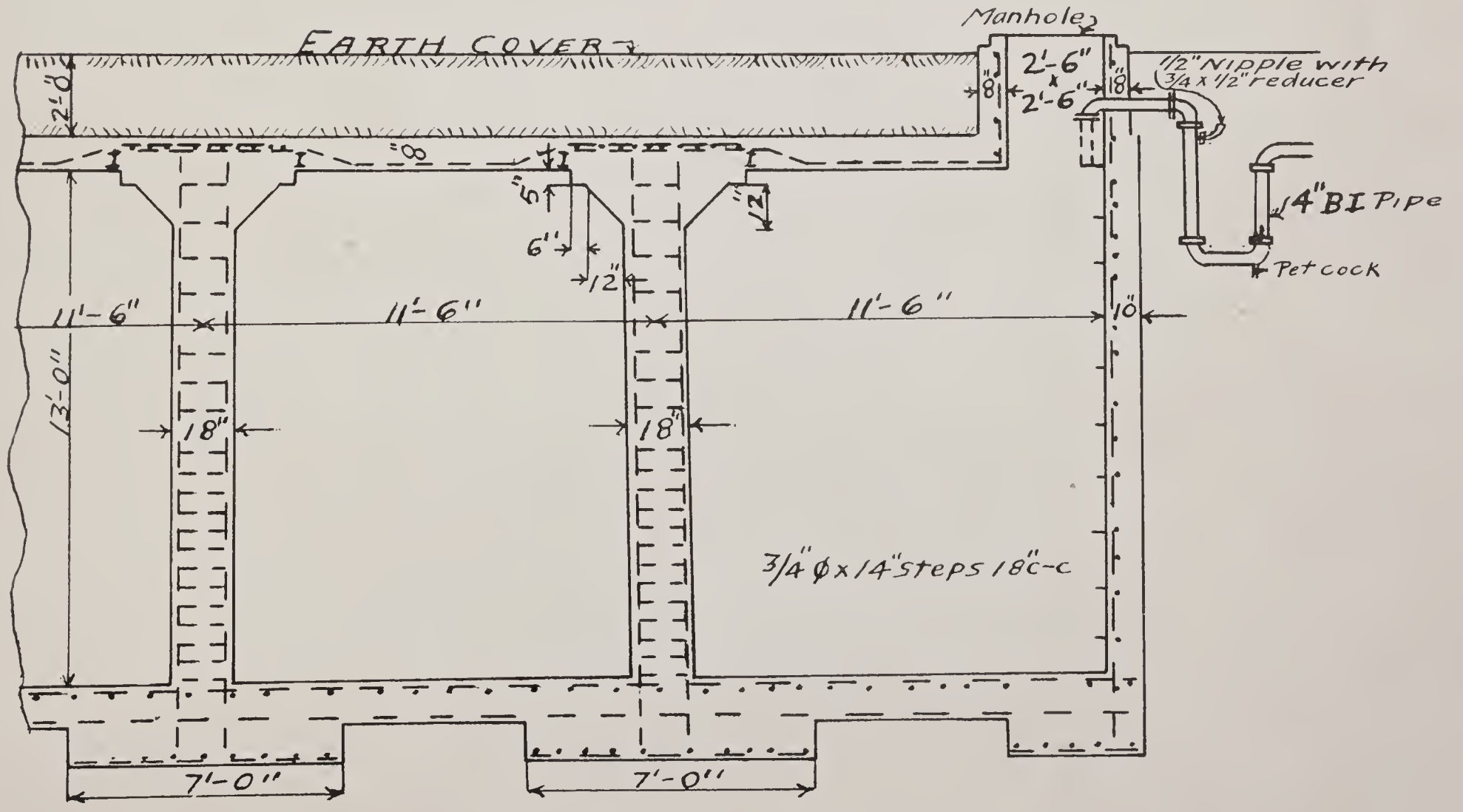


Figure X—Section Through Tank

Ground View of 25,000 Gallon Gas Oil Tank

OWNER AND DESIGNER: *Austin Gas Company, Austin, Minn.*
BUILDER: *H. D. McNish.*
DIMENSIONS: *32 x 12 x 9—built in two compartments.*
KIND OF OIL STORED: *Gas oil.*

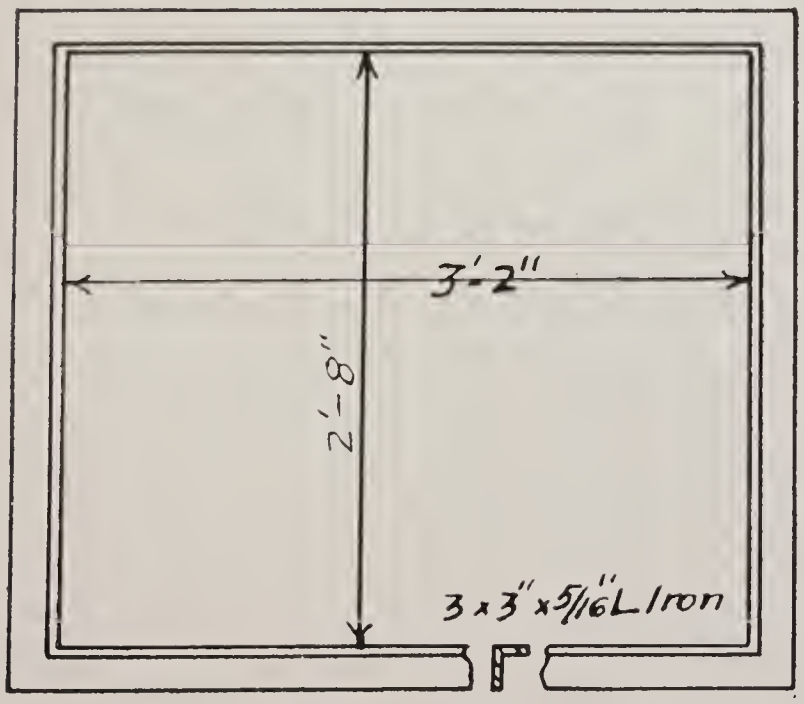
Oilproofed with Smooth-On Iron Cement No. 7.

Figure VI, on the opposite page, shows a steel manhole frame and cover. Under some conditions this type cover is used; however, it is far more desirable to use a concrete cover for the reason that concrete is fireproof.

View Showing 14,600 Gallon Octagonal Tank for Fuel Oil

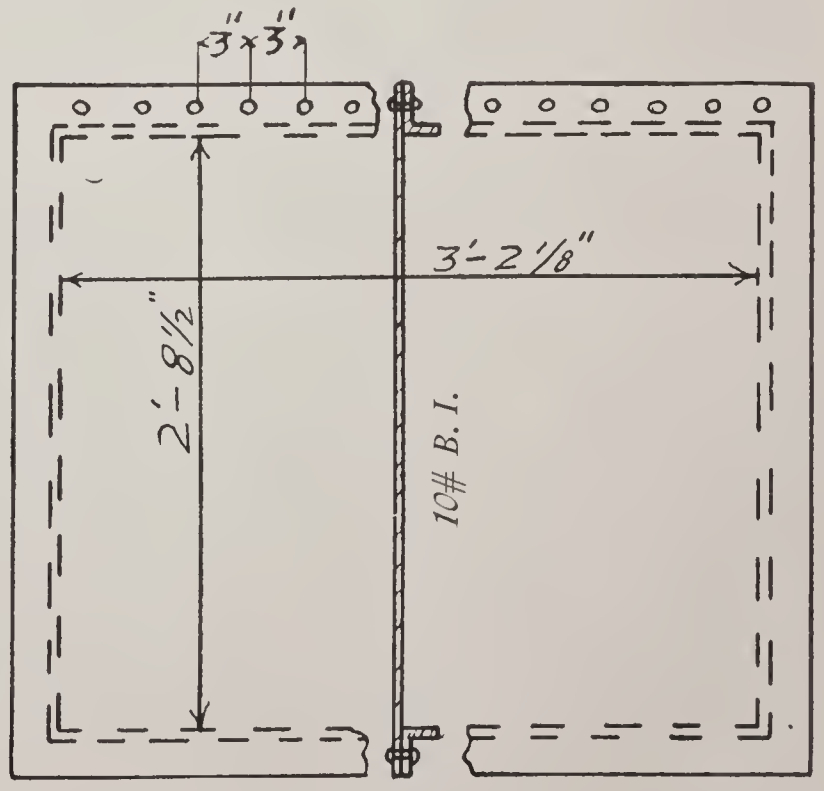
OWNER: *Great Western Smelting and Refining Company, St. Louis, Mo.*
DESIGNER AND BUILDER: *Hoeffner & Company, Chicago.*

THE above photo shows an exterior view of an octagonal tank which is 9 feet high. The interior is circular and 16 feet 8 inches in diameter. It is oilproofed with Gardner Barada compound.



Manhole Frame

Figure VI



Manhole Cover

100,000 Gallon Tank for Fuel Oil

Interior View of Above Tank

OWNER: *General Electric Company, Erie, Pa.*
DESIGNER AND BUILDER: *Con-Oil Tank Company, 1215 Fulton Building, Pittsburgh, Pa.*

Special Features for Consideration in Design and Construction

DESIGN

THE design of a reinforced concrete oil storage tank is a problem which should be solved by a competent, concrete designing engineer. The two most important features of tank design are the foundation and the temperature reinforcing steel. It is always necessary to make a thorough investigation of the soil conditions to determine the bearing capacity. A designer is often allowed a choice as to the position of the tank, either above or below ground. Other things being equal, the underground tank should be selected because of the more even temperature maintained, which reduces the loss of oil by evaporation to a minimum. It is also advisable for the designer to obtain full information regarding the probable plant developments, in order that the tank can be designed to sustain the heaviest loads which these improvements might impose upon it.

CONSTRUCTION

The construction work should be done by a concrete construction company, supervised by an individual, who has had a wide experience in concrete work calling for exact and careful workmanship. If the particular features of the design are not carried out with absolute precision in the actual construction, a failure will surely result. Therefore, it is advisable to have the designer inspect the construction as it progresses.

After the completion of the excavation, the soil should be examined by the engineer, before the concrete work is started. This gives the engineer an opportunity to check up the actual conditions, with the estimated conditions, as shown by the test pits or borings.

MATERIALS *of* CONSTRUCTION

It is not intended to give a complete specification for the materials of construction in this book. However, the idea is to emphasize the qualities, which have proven of utmost importance in this class of construction:

Cement—All Portland cement used, shall pass the standard specifications for Portland cement of the American Society for Testing Materials.

Aggregates—There are three essential tests to be made on the fine aggregate:

1. Sieve analysis, which definitely tells whether the sand is well graded or not.
2. Colorimetric Sand Test, for organic impurities.
3. Test for clay or loam content.

Water—The water shall be free from oil, acid, strong alkalies or vegetable matter.

PROPORTIONS

The materials shall be proportioned so that the most dense concrete is obtained. Concrete has always been thought of as a mixture of cement, sand and pebbles or crushed stone. It has been found recently that we have been disregarding one of the most important constituents—the water. It has been shown by laboratory experiment that a concrete, mixed with 7.5 gallons of water (1 cu. ft.) to one sack of cement (allowance being made for the absorption of aggregate) gave a strength of 1,670 lbs. per sq. inch. Using 6 gallons of water per sack of cement—2,600 lbs. per sq. inch. Using 5.75 gallons of water per sack of cement—2,770 lbs. per sq. inch. These results indicate, that when a mixture of 1:1½:3 is used, the water content should be 5½ gallons per sack of cement. This data will surely emphasize the fact that more care should be used in measuring the amount of water.

PLACING CONCRETE

The concrete shall be placed continuously, so that a monolithic structure results.

OILPROOFING

Where oilproofing is necessary, it will be found that after the proper material has been chosen, the workmanship is of utmost importance.

CURING

Fill the tank with water for about 4 weeks; or use three or four coats of 1:4 solution of 40 degrees Be. sodium silicate, followed with a finish coat of 1:2 solution.

[*Page Twenty-one*]

Additional Examples of Reinforced Concrete Fuel Oil Tanks

Tanks for Which no Oilproofing Was Used

FAIRBANKS, MORSE & COMPANY, Beloit, Wis.—*Five* 35,000 gallon buried tanks about 32 x 11 x 12 feet. Designed and built by the Manufacturing Department of this company in 1916 and 1917. Floors and walls 12 inches thick of 1:2:4 concrete, reinforced and poured continuously. No oil-proofing material was used. Tanks are filled with Oklahoma oil, ranging from 28 to 30 degrees Be., and have been satisfactory so far.

UNION SWITCH AND SIGNAL COMPANY, Swissvale, Pa.—*Two* 75,000 gallon buried concrete tanks 75 x 15 x 9½ feet, each divided into four equal compartments, were designed and built by this concern in September, 1917. Bottoms and walls are 12 inches thick of 1:2:4 concrete, reinforced and poured continuously. The only oil-proofing consisted of a surface treatment of one to four solution of sodium silicate, painted on the surface. So far the tanks have been satisfactory and this concern is now erecting two other tanks of the same general dimensions, each divided into three compartments.

WESTINGHOUSE AIR BRAKE COMPANY, Wilmerding, Pa.—*Four* 25,000 gallon buried tanks about 25 x 15 x 9 feet, designed and built by the Engineering Department of this company, in September, 1917. Floors are 15 inches thick and walls 10 inches thick of 1:2:4 concrete, reinforced, with joint between floor and side walls, containing galvanized iron strip 6 inches wide. No oil-proofing material was used, but inside of tank was plastered with 1:1 mortar troweled smooth. These tanks are filled with Pennsylvania oil ranging from 28 to 32 degrees Be., and have been entirely satisfactory. This concern is now constructing six more tanks of the same capacity, making a total of 250,000 gallons.

DESERT POWER AND MILL COMPANY, Millers, Nev.—*One* 145,000 gallon tank, 75 x 25 x 8 feet, built in 1906. A brief description of this tank was given in the *Engineering News* of July 4, 1907. The walls and floors are 4 inches thick and no special oil-proof treatment was applied. A recent letter from the Superintendent, to the Portland Cement Association, contained the statement that there had been no repairs, the tank being in good condition, without any leaks observable.

DEWEY PORTLAND CEMENT COMPANY, Dewey, Okla.—*Two* 18,000 gallon tanks, built in 1907-1910. These tanks were constructed of 1:1:1½ concrete. No mortar finish was applied to the inside of the concrete after the removal of the forms, nor was any oil-proofing material used. In October, 1917, this concern wrote that "this tank is still very satisfactory, and we see no signs of weakness whatsoever. This tank is now seven years old and seems to be in just as good shape as when it was constructed."

In addition to the above, there are on record, a number of smaller tanks, ranging from five to ten thousand gallons, which were constructed without any oil-proofing, and which have been satisfactory. For example, the El Paso and Southwestern Railroad Company, at various places along its system, has for the past five years been storing fuel oil of 24 to 38 degrees Be. in circular concrete tanks about 12 feet in diameter by 6 feet deep. The bottoms of these tanks are 8 inches thick and the sides 6 inches thick of 1:2:4 concrete. Tanks, that have been in use five years, have been examined inside and outside, but no signs of leakage were discovered.

A refining company at Fort Smith, Ark., has two rectangular concrete tanks, one 10 x 14 x 6 feet and the other 8 x 10 x 5 feet, which have been successfully used for the storage of oils up to 42 degrees Be. for the past seven years. There is nothing unusual in the construction of these tanks, except that they are made of carefully selected aggregate, well mixed and carefully tamped. No oil-proofing materials were used.

The following is a list of some of the additional companies who conserve oil in concrete storage:

HEAVY OILS

Associated Oil Company	San Francisco, Cal.	400,000,000
Garden City Sugar and Land Company	Garden City, Kan.	100,000,000
Kern Trading and Oil Company	Bakersfield, Cal.	37,500,000
Standard Oil Company	El Segundo, Cal.	25,000,000
General Petroleum Company	Los Angeles, Cal.	21,000,000
American Steel and Wire Company	Worcester, Mass.	1,000,000
North American Refining Company	Sheffield, Mo.	840,000
Anadarko Cotton Oil Company	Anadarko, Okla.	573,000
International Braid Company	Providence, R. I.	400,000
San Antonio Gas and Electric Company	San Antonio, Texas	380,000
Newport Mining Company	Carrollville, Wis.	348,000
Federal Glass Company	Columbus, Ohio	300,000
Peace Dale Manufacturing Company	Peace Dale, R. I.	300,000
The American Brass Company	Company's Plants	220,000
The Ozark Refining Company	Fort Smith, Ark.	260,000
Lone Star Brewing Association	San Antonio, Texas	228,000
Clearmont Paper Company	Clearmont, N. H.	215,000
Illinois Oil Company	Rock Island, Ill.	160,000
Thomas Plant Shoe Company	Roxbury, Mass.	160,000
Genckes Spinning Company	Pawtucket, R. I.	150,000
Oilton Refining Company	Oilton, Okla.	125,000
W. H. Jameson	Corona, Cal.	110.000
Davidson County Turnpike Board	Nashville, Tenn.	100,000
Versailles Sanitary Fibre Company	Versailles, Conn.	72,000
Packard Motor Car Company	Detroit, Mich.	63,500
Greenlee Bros. & Co.	Rockford, Ill.	63,000
Winters Cotton Oil Company	Winters, Texas	50,000
Shawnee Gas and Electric Company	Shawnee, Okla.	40,000
Indiana Valley Railway Company	Paxton, Cal.	32,000
Charles City Gas Company	Charles City, Iowa	30,000
Jones & Lamison Machine Company	Springfield, Vt.	30,000

LIGHT OILS

Imperial Oil Company, Ltd.	Toronto, Canada	228,000
Muskogee Refining Company	Muskogee, Okla.	225,000
American Brake Company	St. Louis, Mo.	65,000
San Antonio Gas & Electric Company	San Antonio, Texas	40,000
Moline Oil Company	Clinton, Ohio	24,000
T. F. Stroud & Co.	Omaha, Neb.	12,000

OIL

Union Oil Company of California	San Luis Obispo, Cal.	190,000,000
Empire Gas and Fuel Company	Gainesville, Texas	15,000,000
Curtis & Co.	St. Louis, Mo.	1,500,000
Newport Hydro-Carbon Company	Carrollville, Wis.	850,000
Studebaker Corporation	Detroit, Mich.	825,000
Symington Chicago Corporation	Chicago, Ill.	750,000
Gorham Manufacturing Company	Providence, R. I.	305,000
Lonsdales Manufacturing Company	Lonsdales, R. I.	280,000
Neha Refining Company	Lexington, Ky.	150,000
Westinghouse Electric and Manufacturing Company	East Pittsburgh, Pa.	125,000
Yale & Towne Manufacturing Company	Stamford, Conn.	117,000
Aluminum Castings Company	Cleveland, Ohio	115,000
Wellman-Seaber-Morgan	Cleveland, Ohio	103,000
American Brass Company	Columbus, Ohio	100,000
Holtzer-Cabot Electric Company	Boston, Mass.	100,000
Wallingford Manufacturing Company	Wallingford, Vt.	100,000
Bonney-Floyd Company	Columbus, Ohio	90,000
Shaw-Kendall Engineering Company	Lakewood, Ohio	88,000
Valley Forging Company	Verona, Pa.	86,000
Pittsburgh Seamless Tube Company	Beaver Falls, Pa.	70,000
Bossert Corporation	Utica, N. Y.	60,000
Mathews Gravity Carrier Company	Ellwood City, Pa.	27,000
Neely Nut and Bolt Company	Pittsburgh, Pa.	21,000
Aspronet Company	Economy, Pa.	20,000
Beaver Rubber Company	Providence, R. I.	10,000

Concrete Tanks for Fuel Oil Storage

National Fire Protection Association Committee Submits Tentative Specifications

THE proper construction of concrete tanks for the storage of fuel oil along lines that will reduce as much as possible the fire hazard, has been the subject of consideration of the Committee of Inflammable Liquids of the National Fire Protection Association. The Committee now submits the following tentative specifications for the consideration of its members:

Setting of Tanks—(*a*) Tanks, if underground, shall be buried, so that the top of the tank will be not less than three feet below the surface of the ground and below the level of any piping, to which the tanks may be connected.

(*b*) Tanks shall be set on a firm foundation.

(*c*) All tanks shall be provided with a concrete or other non-combustible roof.

Material and Constrnction of Tanks—(*a*) *Reinforcement*—Sufficient steel reinforcement shall be used to resist the oil pressure, and the horizontal and vertical reinforcement shall be properly proportioned and located to reduce the shrinkage cracks, so that they will be too minute to permit leakage. The fibre stress in the steel shall not exceed 10,000 pounds per square inch. (*Note*—A fibre stress of 10,000 pounds per square inch should prevent shrinkage cracks, although a number of tanks have been designed with a fibre stress of 6,000 to 8,000 pounds.)

(*b*) *Concrete*—The concrete for floor and walls shall be at least 8 inches thick, mixed in the proportion of 1:2:3, or better, 1:1½:3, and having the coarse aggregate of clean, dense, crushed rock or gravel, ranging in size from one inch down. The concrete shall be thoroughly mixed, carefully placed and worked around the reinforcement. The forms should not be held together by wire, as is frequently done in building construction, because leakage is likely to take place along the wire. The concrete shall preferably be poured in a continuous operation so as to form a monolithic construction.

(*Note*—Where this cannot be done, the bottom shall be poured without joints, and the walls as a second continuous operation. One method of making a joint tight, between the bottom of the tank and the walls, is by means of a strip of galvanized iron 6 inches wide, with joints riveted and soldered, so as to form a continuous band. This strip should be vertically embedded 3 inches in the floor slab and on the center line of the wall. The floor slab under the walls should be thoroughly cleansed, and before pouring the walls a mixture of 1:1 mortar should be placed in the bottom of the forms and around the galvanized strip to make a tight joint.)

[*Page Twenty-four*]

(*c*) *Finish*—As soon as the wall and sides have been poured, the floor shall be floated and troweled smooth. The wall forms shall be removed as soon as the concrete has hardened sufficiently to be self-sustaining, and all projections and irregularities shall be removed from the surface, and all cavities filled with a 1:1 mortar, thoroughly rubbed in and troweled smooth. No plastering shall be applied.

(*d*) *Aging*—The concrete shall be allowed to harden at least thirty days, and longer if possible.

(*Note*—To assist in the setting of the concrete before it becomes oil-soaked, it is advantageous to use several priming coats of a 1:4 solution of 40 degree Be. sodium silicate, followed by a finish coat of 1:2 solution. This forms a glazed surface on the concrete, which, although it is not permanent, gives the concrete an opportunity to harden, until the protection from the silicate of soda is no longer necessary.)

Location of Pipe Connections—All pipe connections to the tank shall be made through the top.

Venting of Tanks—(*a*) Tanks, shall be provided with a permanently open vent, or with a combined fill and vent fitting, so arranged, that the fill pipe cannot be opened without opening the vent pipe.

(*b*) Vent openings shall be screened (30 x 30 brass mesh or equivalent) and shall provide sufficient area for allowing proper flow of liquid during the filling operation. Permanently open vent pipes, shall be provided with weather-proof hoods and terminate at a point at least 12 feet above the top of the fill pipe, and never within less than 3 feet, measured horizontally and vertically from any window or other building opening. Where a battery of tanks is installed, vent pipes may be run into a main header. Individual vent pipes should, however, be screened between tank and header, and connection to the header should be not less than one foot above the level of the top of the highest reservoir from which the tanks may be filled.

(*c*) Fill pipe shall be screened, and when installed in the vicinity of a building, shall not be located within 5 feet of any door or other opening and shall terminate in a metal box or casting, provided with means for locking."

10 Reasons Why **YOU** Should Build Oil Tanks of Concrete

1. ECONOMICAL. In first cost. Cheaper than steel. No maintenance, no painting, no repairing.

2. FIREPROOF. Insurance rates not raised on surrounding buildings. Low rate on contents of tank.

3. PERMANENT. Does not deteriorate; lasts forever.

4. RAPID CONSTRUCTION. Tanks of large capacity built in few weeks.

5. ADAPTABLE. Placed under ground—surface area can be used for railroad tracks, storage of materials or other manufacturing purposes.

6. MATERIALS OBTAINABLE. Materials generally near site. Steel rods obtained readily, from small rolling mills, at times when it is impossible to obtain plate for steel construction.

7. UNSKILLED LABOR UTILIZED. Successfully constructed by unskilled labor under competent supervision.

8. EVAPORATION REDUCED.

9. EFFICIENT. More capacity at same cost, thereby allowing greater reserve storage.

10. COMPLETELY SATISFACTORY. The owner, the designer and the builder, derive constant satisfaction from a properly designed, well-built concrete oil storage tank.

When you build, make Atlas Portland Cement your choice
"The Standard by which All Makes are Measured"

Further Information

All those interested in the storage of oil can obtain more complete information about the construction of Oil Storage Tanks of Concrete by consulting in person or by writing

Technical Department

The Atlas Portland Cement Company

30 Broad Street, New York City

Corn Exchange Bank Building

Chicago, Illinois